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Effect of split marketing on the welfare, performance, and carcass traits of finishing pigs[1]

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ABSTRACT

The aim of this study was to compare a split marketing (**SM**) strategy whereby the heaviest pigs in a group are removed and slaughtered earlier than the others with an "All-Out" (**AO**) marketing strategy, whereby all pigs are removed from the pen simultaneously and slaughtered on the same day in terms of welfare, performance and carcass traits of noncastrated (i.e. intact) male and female pigs. The experimental treatments were arranged in a 2x2 factorial array with: (1) marketing strategy (SM *vs*. AO) and (2) gender (Males *vs*. Females), which yielded 4 treatment groups of 14 pigs (73.1 ± 4.8 kg): Male-SM, Male-AO, Female-SM and Female-AO (7 replicates/group). Pigs in AO groups were all slaughtered after 6 wk on trial, while in SM groups the 3 heaviest pigs were removed and slaughtered 2 wk before the remainder of the group, which were slaughtered at the same time as the AO pigs. Pigs were fed a liquid diet from a long trough 3 times daily. Behavioral observations were conducted before and after SM, the day of SM, and 1 and 2 wk later. Behavior was recorded both during and between feed events and skin lesions were scored on all, except the 3 pigs removed from SM groups, before and 2 wk after SM. Growth performance, feed efficiency and carcass traits were recorded. The number of aggressive interactions during feed events decreased after the 3 pigs were removed from SM groups. This reduction in aggressive interactions was observed on the day of split marketing in male groups (before SM: 24.3 *vs*. the day of SM: 14.7, SED = 3.31, $P < 0.05$ for interaction) and in subsequent observations in female groups (before SM: 21.4 *vs*. days after SM: 13.4, SED = 3.31, $P < 0.05$ for interaction). However, SM had no effect on behaviors recorded between feed events or on the number and severity of skin lesions ($P > 0.05$). There were no differences between the 11 remaining pigs in SM groups and the 14 pigs in AO groups in terms of growth performance, feed efficiency, and carcass traits of either female or intact male pigs ($P > 0.05$). However, reduced within-pen CV in carcass weight was detected in pigs from SM groups compared with pigs from AO groups (8.6 *vs*. 10.9, SEM = 0.72, $P < 0.05$). Therefore, in restrictively-fed pigs, a SM strategy improved the welfare of both female and intact male pigs by reducing aggressive interactions during feeding but had no impact on performance or carcass traits.

Key words: behavior, carcass traits, growth performance, intact male pigs, split marketing, welfare

INTRODUCTION

The likely legislation against castration of male pigs has led to a growing interest in the management practices for noncastrated (intact) male pigs. Sexual and aggressive behaviors in intact male pigs lead to welfare issues, particularly during the finishing stage (Olesen et al., 1996; Cronin et al., 2003). The way in which pigs are marketed alters their social environment, which is one of the factors that influences sexual and aggressive behaviors (O'Connell et al., 2005a; Hemsworth and Tilbrook, 2007). "All-Out" marketing strategies are common, whereby pigs in a pen are marketed together. With such strategies, floor-space allowance may become restricted near the end of the finishing stage and increase in aggression may be exacerbated by restricted feeding systems and heavier slaughter BW. Contrastingly, with "split marketing" strategies (SM), the heaviest pigs in a pen are removed and slaughtered before the others, which increases floor-space allowance of the remaining pigs. However, removing animals from a group could disrupt its social structure, resulting in an increased aggression, which is thought to reflect social stress (Burman et al., 2008). Whereas Boyle and Björklund (2007) found no effect of SM on pig behavior, Fredriksen and Hexeberg (2009) reported an increase in fighting. Rydhmer et al. (2004) saw a reduction in aggression at feeding after SM, but an increase in individual aggressiveness. In all the aforementioned studies pigs were fed at specific times during the day (restrictively fed). There are limited studies on the impact of SM on growth performance of intact male pigs (O'Connell et al., 2005b), and conflicting results in studies on castrated pigs fed for *ad libitum* intake (Scroggs et al., 2002; Knauer et al., 2004; Dedecker et al., 2005). The aim of the present study was to evaluate the effect of SM on welfare, growth performance, and carcass traits of intact male and female pigs, when restrictively fed and slaughtered at a target BW of 105 kg.

MATERIAL AND METHODS

Care and use of animals

This experiment complied with EU Council Directive 2001/88/EC laying down minimum standards for the protection of pigs, and EU Council Directive 98/58/EC concerning the protection of animals kept for farming purposes.

Animals

At the start of the finishing period (12 wk of age), 14 pens of female and 14 pens of intact male crossbred pigs (Landrace x Large White dams mated to Large White boars), each containing 14 pigs, were formed. All 392 pigs were individually identified by ear tags. When the average pen BW reached 73.1 ± 4.8 kg (19 ± 1 wk of age), each pen was blocked on the basis of age and BW, and assigned randomly to treatment in a randomized complete block design. The treatments were arranged in a 2 × 2 factorial array with: (1) marketing strategy (SM *vs*. AO) and (2) gender (Males *vs*. Females), which yielded 4 treatments: Male-SM (n = 7 pens), Male-AO (n = 7 pens), Female-SM (n = 7 pens), and Female-AO (n = 7 pens). In AO groups, all 14 pigs were removed from the pen and slaughtered 6 wk after the start of the experiment (25 ± 1 wk of age). In SM groups, the 3 heaviest pigs were removed from the pen 4 wk after the start of the experiment and slaughtered. The 11 remaining pigs were removed from the pen and slaughtered 2 wk later, on the same day as pigs in the AO groups. Pigs were killed at the abattoir by exsanguination after CO_2 stunning.

Housing and diet

Pigs were housed on fully-slatted floors in a pen with a surface area of 9.52 m^2. One empty plastic drum was provided to the pigs in each pen. Pigs were fed a liquid diet (3.3 kg of water/kg of fresh feed, Table 1) from 1 long-trough (4.78m x 0.21m) per pen, 3 times daily (24% of the total quantity of food in the morning at 0910, 42% in the afternoon at 1410, and 34% at night at 2110). The food was delivered using a computerized liquid feed system (Big Dutchman, Vechta, Germany).

Data collection

Behavioral data. All pigs were individually identified by a mark on their back. Observations were made on the 2 d before SM (average of the 2 d: **PRE**), the day of SM (**dSM**), on the 2 d after SM (average of the 2 d: **POST**), and during 1 d 1 and 2 wk later (average of the 2 d: **WKS**). Behavioral observations were made between and during feed events.

During feed events, all occurrences of aggressive behavior were recorded for a 1-min period 10 min before food delivery and for a 2-min period after food delivery. The number of aggressive interactions was summed for these 3 min observations per pen. Aggressive behaviors during the night feed event (i.e. at 2110) were only recorded on 1 d before SM, the day of SM and on 1 d after SM.

Between feed events, 2-min direct observations of each of the 14 pigs in a pen were conducted (i.e. 28 min of observations per pen in total from 0900 until 1700). The behaviors recorded were sleeping (lying eyes closed), social contact (nose to nose or other part of pigs body), exploration (rooting, smelling or licking the physical surroundings), feeding, inactive (eyes open but doing nothing), aggressive (biting, head knock and fighting), and sexual (mounting) behavior, as well as the postures (standing, lying or dog sitting). Duration of each behavior and posture was calculated as a percentage of the observation time to give an estimation of the pig's activity and postural time budgets. At the same time, all occurrences of aggressive and mounting behaviors in the pen were recorded, and the number of aggressive behaviors and mounts performed per pig was calculated by dividing the total count for a particular behavior by the number of pigs in the pen.

Skin lesions. The day before SM (**pre-SM**) and the day before the final slaughter (**post-SM**), the number of lesions and the severity of each lesion was recorded for all pigs (except the 3 heaviest pigs in the SM group). These inspections were conducted while the pigs were being weighed. Each lesion was scored from 0 to 4 (0 - no lesion, 1 - 1 superficial lesion, 2 - more than 1 superficial or 1 red lesion, 3 - more than 1 red lesion, 4 - 1 red open wound) (Ellis et al., 1983; Boyle and Björklund, 2007).

Growth performance, feed efficiency, and carcass traits. All pigs were individually weighed the day they were assigned to the experiment, 4 wk later and on the day of slaughter. Pen feed intake was recorded at each weighing event. The G:F ratio was calculated by dividing the ADG by the ADFI. Values were calculated for the period from the start of the experiment until 4 wk later (pre-SM, n = 14 pigs/pen in both treatments) and for the period following SM to slaughter 2 wk later (post-SM, n = 14 pigs/pen in AO groups and n = 11 pigs/pen in SM groups). Chilled carcass weight was measured at the abattoir. Kill-out percentage was calculated as (carcass weight / live BW at slaughter) x 100. Backfat and muscle depth were measured at 6 cm from the edge of the split back at the level of the third and fourth last ribs using a Hennessy Grading probe (Hennessy and Chong, Auckland, New Zealand). Lean meat yield was calculated according to the following formula: lean meat yield = 60.30 – 0.847 X_1 + 0.147 X_2 (where X_1 = backfat depth (mm) and X_2 = muscle depth (mm)), and expressed as a percentage. The within-pen CV was calculated for slaughter and carcass weights, fat and muscle depths, and lean meat yield by dividing the within-pen standard deviation value by pen mean value, and expressed as a percentage. Feed intake was measured on a pen basis whereas all other data were collected from individual pigs and used to calculate the pen mean.

Statistical analyses

The data were analyzed using GenStat version 11 (performance and skin lesion data) and version 12.1 (behavior data) (VSN international Ltd). For all analyses, fixed effects were marketing strategies (SM *vs*. AO) and gender (Males *vs*. Females).

The number of aggressive behaviors within a pen and per pig during the feeding events was analyzed by REML variance components analysis for repeated measures. Morning and afternoon feeding events were combined. For these feeding events, observation periods (PRE, dSM, POST, and WKS) were added to the model. For the night feeding event, observation days (day before SM, day of SM, and day after SM) were added as fixed effects. Data were analyzed using the pen as the experimental unit (AO: 14 pigs/pen throughout the 6 wk of experiment; SM: 14 pigs/pen during 4 wk then 11 pigs/pen during the last 2 wk), with pen and day as random effects.

Behavioral data between feeding events were analyzed by REML variance components analysis for repeated measures. Observation periods (PRE, dSM, POST and WKS) were added as effects. Data were analyzed using the pen unit (AO: 14 pigs/pen; SM: 14 pigs/pen then 11 pigs/pen), with pen and observation periods as random effects. In SM groups, an additional REML repeated measure was conducted excluding the behavioral data from the 3 heaviest pigs before their removal; therefore the behavior between feeding events for the 11 pigs before the removal of the 3 heaviest pigs was compared with their behavior after the removal of the 3 heaviest pigs.

The number and severity of skin lesions were analyzed by ANOVA, with period (pre-SM and post-SM) included as effects and data blocked by pen and period.

Weights and carcass traits were analyzed by ANOVA with the initial BW as covariates, where marketing strategies, gender and their interactions were assessed. Data were analyzed using the pen unit (AO: 14 pigs/pen *vs*. SM: 14 pigs/pen) and also by considering only the pigs slaughtered at the end of the 6 wk of experiment (AO: 14 pigs/pen *vs*. SM: 11 pigs/pen).

Data for ADFI, ADG, and G:F were also analyzed by ANOVA with period (pre-SM and post-SM) added as effects and data blocked by pen and period. Data were analyzed using the pen as the experimental unit (AO: 14 pigs/pen; SM: 14 pigs/pen then 11 pigs/pen).

Effects were considered significant if $P < 0.05$. If a *P*-value was between 0.05 and 0.10, it was considered a tendency. Data analyzed with ANOVA are expressed as means ± SEM. Data analyzed with REML are expressed as means ± SED.

RESULTS

Behavior

Aggressive behavior during feed events. For the morning and afternoon feed events combined (6 min of observation per day), there were interactions between gender, observation period and marketing strategy for the number of aggressive interactions in the pen ($F_{(3,73.5)} = 3.37$, $P = 0.023$, Figure 1a) and per pig ($F_{(3,73.7)} = 2.77$, $P = 0.048$, Figure 1b). In SM groups, the removal of the 3 heaviest pigs led to a reduction in the number of aggressive interactions compared with AO groups. This was significant in male groups on the day of SM, and in female groups during subsequent observation periods. In AO female groups, the number of aggressive interactions in the pen increased across the observation periods, but no increase in aggression was seen in AO male groups.

For the night feed events, there were significant interactions between observation day and marketing strategy for the number of aggressive interactions within the pen ($P = 0.001$), and more importantly, per pig ($P = 0.042$) (Figure 2). In SM groups, the number of aggressive interactions within the pen decreased after the removal of the heaviest pigs, whereas in AO groups the number of aggressive interactions did not differ between observations. The number of aggressive interactions per pig was lower in SM groups compared with

AO groups on the day of SM and on the day after SM. Females performed a similar number of aggressive interactions per pig than males (1.0 vs. 0.9; SED = 0.12, $P = 0.555$) during the night feed events, regardless of observation day.

Behavior between feed events. There were no interactions between factors and observation period, therefore only main effects of marketing strategy and gender are presented (Table 2).

There was no effect of marketing strategy on the activity (i.e. percentage of time spent sleeping, in social interactions, exploring, and inactive) or postural time budgets of the pigs ($P > 0.05$). Furthermore, there was no effect on the time spent engaged in mounting behavior ($P > 0.05$). However, pigs in SM groups spent more time engaged in aggressive interactions than pigs in AO groups, regardless of the observation period ($P = 0.022$). This difference in the percentage of time spent in aggressive interactions tended to be related to the male groups (Male-AO: 0.23%, Male-SM: 0.64%, Female-AO: 0.11%, Female-SM: 0.18%; SED = 0.143, $P = 0.09$). There was no effect of marketing strategy on the number of mounts ($P = 0.42$) or on the number of aggressive behaviors performed per pig ($P = 0.60$).

There were no interactions between marketing strategy and observation period when considering the activity time budgets of only the 11 pigs in the SM groups ($P > 0.05$). Therefore, the removal of the 3 heaviest pigs did not disrupt the activity time budgets of the 11 remaining pigs: sleep (29.3% before *vs*. 38.4% after), social contact (6.3 *vs*. 5.8%), exploration (29.1 *vs*. 27.2%), inactivity (30.1 *vs*. 25.1%), other (4.7 *vs*. 2.7%), aggressive interactions (0.5 *vs*. 0.4%), and mounting (0.1 *vs*. 0.5%) ($P > 0.05$).

There was no effect of gender on the duration of time spent engaged in social or exploratory behavior, sleeping, feeding or inactive ($P > 0.05$). Males spent more time mounting ($P < 0.001$) and engaged in aggressive interactions ($P = 0.005$) than females, and performed more mounts per pig and more aggressive interactions per pig than females ($P < 0.001$).

Skin lesions

There were no interactions between marketing strategy, gender, and period ($P > 0.05$). Pigs in AO and SM groups had a similar number of skin lesions before SM (10.6 *vs*. 9.5, respectively) and after SM (11.5 *vs*. 9.0, respectively; SEM = 1.19, *P* = 0.134). Similarly, pigs in AO groups had a similar lesion severity score to pigs in SM groups before (2.0 *vs*. 1.9, respectively) and after SM (1.9 *vs*. 2.0, respectively; SEM = 0.07, *P* = 0.282).

Females had a similar number of lesions to males (9.1 *vs*. 11.1, respectively; SEM = 1.14, *P* = 0.225), but females had more lesions of scores 2-3 whereas males had more lesions of scores 1-2 (SEM = 0.06; *P* = 0.002).

Growth performance and feed efficiency

Considering the pen unit (n = 14 pigs), there were no interactions between factors on weight, thus only main factors are presented in Table 3. There was no effect of marketing strategy on the initial BW, the BW at 23 wk of age and on the pen slaughter BW, as well as on the CV for these data (*P* > 0.05). The 11 remaining pigs in SM groups (the ones remaining at the end of the 6 wk) had a similar slaughter BW (101.9 kg *vs*. 103.9 kg; SEM = 0.84, *P* = 0.102) to pigs in the AO groups, with similar within-pen CV for slaughter BW (9.06 *vs*. 9.95%; SEM = 0.715, *P* = 0.39). Males were heavier than females at 23 wk of age (*P* = 0.018) and at slaughter (*P* = 0.008).

There were no interactions between gender, marketing strategy and period (pre- vs. post-SM) on the ADFI, ADG, and G:F (*P* > 0.05). Pigs in AO and SM groups had a similar ADFI (2313 *vs*. 2331 g.d^{-1}; SEM = 15.4, *P* = 0.417), ADG (785 *vs*. 789 g.d^{-1}; SEM = 22.2, *P* = 0.903) and G:F (340.0 *vs*. 339.5; SEM = 9.92, *P* = 0.972), regardless of the period.

Carcass traits

Considering the pen unit (n = 14 pigs, Table 3), there was no effect of marketing strategy on chilled carcass weight and kill-out percentage (*P* > 0.05), but pigs in SM groups had a lower within-pen CV in carcass weight than pigs in AO groups (*P* = 0.033). Pigs in SM groups had a similar muscle depth (*P* = 0.452), but a greater fat depth than pigs in AO groups (*P* = 0.034), with no difference in the within-pen CV in fat depth (*P* = 0.429). Pigs in SM groups consequently had a lower lean meat yield (*P* = 0.024) and a greater within-pen CV for lean meat yield than pigs in AO groups (*P* = 0.014). Nevertheless, when only the 11 remaining pigs are considered in SM groups, they had a similar chilled carcass weight (78.3 kg *vs*. 78.1 kg; SEM = 0.54, *P* = 0.749), kill-out percentage (76.4% *vs*. 75.6%; SEM = 0.46, $P = 0.26$), fat depth (10.3 mm for both; SEM = 0.19, $P = 0.824$), muscle depth (49.3 mm *vs*. 49.1 mm; SEM = 0.44, $P = 0.749$), and therefore, lean meat yield than pigs in AO groups (58.8% for both; SEM = 0.17, $P = 0.95$).

There was no effect of gender on carcass weight ($P = 0.754$), but females tended to have a lower within-pen CV in chilled carcass weight than males ($P = 0.097$). Females had a greater kill-out percentage ($P = 0.001$) and a greater muscle depth ($P = 0.012$). However, as there was no effect of gender on fat depth ($P = 0.411$) females only tended to have a greater lean meat yield than males ($P = 0.09$).

DISCUSSION

The impact on pig behavior of marketing a pen of pigs at different times or “split marketing” (i.e., SM) was compared with an “all-out” (i.e., AO) marketing strategy whereby all the pigs in a pen were removed and slaughtered simultaneously. In restricted feeding systems, most of the aggressive behavior occurs during feeding (Ewbank and Meese, 1971; Kyriazakis and Whittemore, 2006), so particular attention was paid to pig behavior during this time. In accordance with Rydhmer et al. (2004), but in contrast to Boyle and Björklund (2007), the removal of the 3 heaviest pigs reduced the number of aggressive interactions in the pen and per pig, during feeding, when compared with the pens in which all 14 pigs remained until slaughter (AO marketing strategy). This may be related to the fact that the heaviest, and therefore, probably the most aggressive pigs were the ones that were removed from the pen (Olesen et al., 1996; Andersen et al., 2000; Rydhmer et al., 2004). But it is more likely that there was a reduction in the amount of aggression at feeding because removal of the heaviest pigs meant more space and easier access to the feed trough for the remaining pigs. In contrast, in the AO groups, pigs would have had progressively less space at the trough as they increased in size. According to the results of Spoolder et al. (1999) this should have caused an increase in aggression. Since an increase in aggression was only observed among the female pigs, we hypothesize that females are more disturbed by a reduction in feeding space at the trough than males. This may also explain why the difference in terms of reduced aggression at feeding in SM groups compared with AO groups persisted for longer in pens of females compared with pen of males. In male groups, the reduction in aggression was only seen on the day of split marketing, and this, coupled with the absence of an increase in aggression in male AO groups, may explain why differences between SM and AO groups were only observed over a short-term period.

In accordance with previous studies (Scroggs et al., 2002; Boyle and Björklund, 2007; Fredriksen and Hexeberg, 2009), observations between feed events indicated that the activity time budget of the 11 pigs of interest was not affected by the removal of the heaviest pigs. However, in SM groups the absence of an effect of removal of the heaviest pigs on the number of aggressive interactions per pig is in contrast to the increase in aggressive behavior observed by Fredriksen and Hexeberg (2009) after the removal of the heaviest pigs. These authors worked with groups of 6 pigs where 1 to 4 animals were removed and it is known that pigs have differing social strategies depending on the size of the group they are in (Samarakone and Gonyou, 2009). Therefore, removal of group members from smaller social groups (as in the study of Fredriksen and Hexeberg, 2009) could potentially cause more social stress than in larger social groups leading to an escalation in aggression. In this study, the fact that there was no change in the postural or activity time budgets and no increase in aggressive behavior indicates that neither intact male nor female pigs are affected by the removal of a small proportion of group members in somewhat larger groups.

Our results suggest that intact male pigs in SM groups spent more time engaged in aggressive interactions than those in AO groups. However, this result was not related to the removal of the 3 heaviest pigs as there was no effect of observation day. Pigs in AO and SM groups had similar rearing backgrounds and were balanced according to BW at the start of the experiment so it is difficult to suggest a biological reason for the difference observed.

Aggressive behavior results in skin lesions and scores of such injuries can reflect the severity of a fight (Turner et al., 2006). The lack of a difference in skin lesion scores between pigs in SM and AO groups corresponds to the absence of a difference between groups in aggressive behavior between feeding events. However, the skin lesion scores did not reflect the marked differences recorded in aggression during feeding events between females in the SM (aggression reduced after pigs were removed) and AO (aggression continued to increase until slaughter) treatments. Interestingly, whereas males were more aggressive (i.e. showed a greater number of aggressive behaviours) and performed more mounting, females in general had greater lesion scores than males. Indeed injuries inflicted by females seemed to be more severe as they presented numerous red lesions compared with males. This is not in accordance with the literature (Rydhmer et al., 2004; Andersson et al., 2005), although Giersing and Andersson (1998) found an increase in the intensity of fighting between females as they grew but not in the case of males. If measures of the intensity, in addition to the frequency, of aggression had been employed in the current study it may have aided in the interpretation of the lesion score data.

Ease of access to food could reasonably be expected to increase feed intake and ultimately improve growth rate (Huyn et al., 1998; Scroggs et al., 2002; Wolter et al., 2002; Dedecker et al., 2005; O'Connell et al., 2005b; Street and Gonyou, 2008). However, the removal of the 3 heaviest pigs from a group of 14 did not affect any of the growth performance parameters for either females or intact male pigs. Given the short-term reduction in competition at feeding in the males and the absence of prolonged differences between treatments, no improvement was expected in males. However, the females showed a sustained reduction in feeding related aggression following removal of the 3 heaviest pigs. This was likely related to the increase in trough space allowance, and an improvement in feed intake or growth rate could have been expected. However, in previous studies where removal of pigs from a group facilitated access to food for the remaining pigs and resulted in greater feed intake and growth rates in the remaining animals, pigs were fed for *ad libitum* intake (Scroggs et al., 2002; Dedecker et al., 2005). In such systems, pigs can fully express their potential for feed intake when competition for access to the feeder is reduced. In contrast, the computerized liquid feeding system employed in this study delivered a specific limited amount of food based on the number of pigs in the pen, at 3 specific time points each day. Hence, the pigs were fed somewhat restrictively, and therefore, in spite of reduced competition for access to the feed trough, females in SM groups could not express their potential for greater feed intakes. Indeed our findings are in line with others where split marketing had no effect on growth rates of intact male and female pigs fed restrictively and slaughtered at 90 kg (O'Connell et al. 2005b; Lynch et al., 2006).

In addition, the removal of the heaviest pigs had no effect on the carcass traits of the remaining pigs. Pigs in SM groups had a similar carcass weight, kill-out percentage, fat and muscle depth, and consequently lean meat yield to pigs in AO groups. However, when the values of the 3 heaviest pigs that were removed from the SM groups were added into the analysis, carcass traits of pigs in the split marketed groups deteriorated with an increase in fat depth and therefore a reduction in lean meat yield. Nevertheless, the split marketing strategy reduced within-pen CV in carcass weight, which could help to ensure that all pigs are slaughtered within the target weight range when the best price will be achieved by the producer.

To summarize, a split marketing strategy facilitates the sale of pigs within a tighter carcass weight range with no deleterious effect on the performance and carcass traits of remaining pigs. In addition, when pigs are fed restrictively, this marketing strategy reduces aggression during feeding in both intact male and female pigs but with a more persistent beneficial effect on the females.

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Table 1. Ingredient and chemical composition of the experimental diet (g/kg unless otherwise noted) fed to pigs during the 6 wk of the experiment

Item	Diet
Ingredient	
Barley	364.1
Wheat	404
Soya Hi-Pro	200
Soya oil	10
L-Lys HCl	3.0
DL-Met	0.8
L-Thr	1.0
Limestone flour	13.0
Salt	3.0
Vitamins and mineral premix[1]	1.0
Phytase 5000, IU/g	0.1
Chemical	
DM[2]	870
CP[2]	178
Fat[2]	27
Crude fiber[2]	37
Ash[2]	44
Lys[3]	11.1
DE[3], MJ of DE/kg	13.7
Total P[3]	3.9
Digestible P[3]	2.5
Ca[3]	7.0

[1] Premix provided per kilogram of complete Diet: Cu, 15 mg; Fe, 24 mg; Mn, 31 mg; Zn, 80 mg; I, 0.3 mg; Se, 0.2 mg; vitamin A, 2,000 IU; vitamin D_3, 500 IU; vitamin E, 40 IU; vitamin K, 4 mg; vitamin B_{12}, 15mg; riboflavin, 2 mg; nicotinic acid, 12 mg; pantothenic acid, 10 mg; vitamin B_1, 2 mg; and vitamin B_6, 3 mg

[2] Analyzed values

[3] Calculated values

Table 2. Effects of marketing strategy and gender[1] on the time spent in different behaviors and postures, and on the number of aggressive interactions and mounts per pig (per 2 min), between feeding events, on a pen basis (means ± SED, All-Out: 14 pigs/pen; SM[2]: 14/pen then 11 pigs/pen)

	Marketing strategy				Gender			
Behavior	All-Out	SM[2]	SED	*P*	Females	Males	SED	*P*
Behavior, % of time								
Sleeping	37.6	34.6	3.50	0.436	39.0	33.2	3.50	0.128
Social contact	6.5	6.0	0.96	0.566	6.1	6.4	0.96	0.720
Exploration	23.7	27.4	3.84	0.519	23.5	27.5	3.84	0.300
Feeding	0.1	0.1	0.08	0.839	0.1	0.1	0.08	0.673
Inactive	28.1	27.4	2.27	0.876	28.1	27.3	2.27	0.677
Other	3.7	3.7	1.22	0.953	3.0	4.3	1.22	0.316
Mounting	0.2	0.4	0.16	0.223	0	0.6	0.16	<0.001
Aggressive	0.2	0.4	0.10	0.022	0.1	0.4	0.10	0.005
Mounting, No. per pig	0.02	0.02	0.005	0.420	0	0.04	0.005	<0.001
Aggressive, No. per pig	0.08	0.07	0.011	0.601	0.05	0.10	0.011	<0.001
Posture, % of time								
Lying	63.9	60.9	4.27	0.601	65.2	59.6	4.27	0.254
Standing	27.1	29.6	3.53	0.672	23.7	33.0	3.53	0.011
Dog sitting	6.2	5.7	1.03	0.585	7.9	4.0	1.03	<0.001

[1] No interactions between marketing strategy, gender and observation period detected ($P > 0.05$)
[2] SM: Split marketing

Table 3. Influence of marketing strategy and gender[1] on the growth performance, carcass traits and on CV of each value, for the pen unit (means ± SEM, n = 14 pigs/pen), BW at start was used as covariate

	Marketing strategy				Gender			
Item	All-Out	SM[2]	SEM	*P*	Females	Males	SEM	*P*
BW at start, kg	72.1	74.1	1.32	0.286	73.2	73.0	1.32	0.935
BW CV at start	11.4	12.1	0.80	0.554	11.2	12.3	0.78	0.366
BW at 4 wk, kg	92.2	93.8	0.69	0.106	91.8	94.2	0.68	0.021
BW CV at 4 wk	10.6	11.1	0.72	0.638	10.3	11.4	0.70	0.278
Slaughter BW, kg	104.0	102.9	0.82	0.390	101.8	105.1	0.80	0.008
slaughter BW CV	10.0	8.4	0.70	0.142	8.8	9.6	0.68	0.455
Carcass wt, kg	78.8	78.3	0.54	0.506	78.7	78.4	0.52	0.754
carcass wt CV	10.9	8.6	0.72	0.033	8.9	10.6	0.70	0.097
Fat Depth, mm	10.2	10.8	0.18	0.034	10.4	10.6	0.18	0.411
fat depth CV	17.5	19.2	1.44	0.429	18.8	18.0	1.41	0.698
Muscle Depth, mm	49.3	48.9	0.40	0.452	49.9	48.4	0.39	0.012
muscle depth CV	7.7	7.7	0.62	0.985	7.5	7.9	0.61	0.689
Lean meat yield, %	58.9	58.3	0.17	0.024	58.8	58.4	0.16	0.090
lean meat yield CV	2.5	3.4	0.23	0.014	2.9	2.9	0.23	0.997
Kill-out, %	75.8	76.1	0.44	0.743	77.3	74.6	0.43	<0.001

[1] No interactions between marketing strategy and gender ($P > 0.05$)
[2] SM: Split marketing

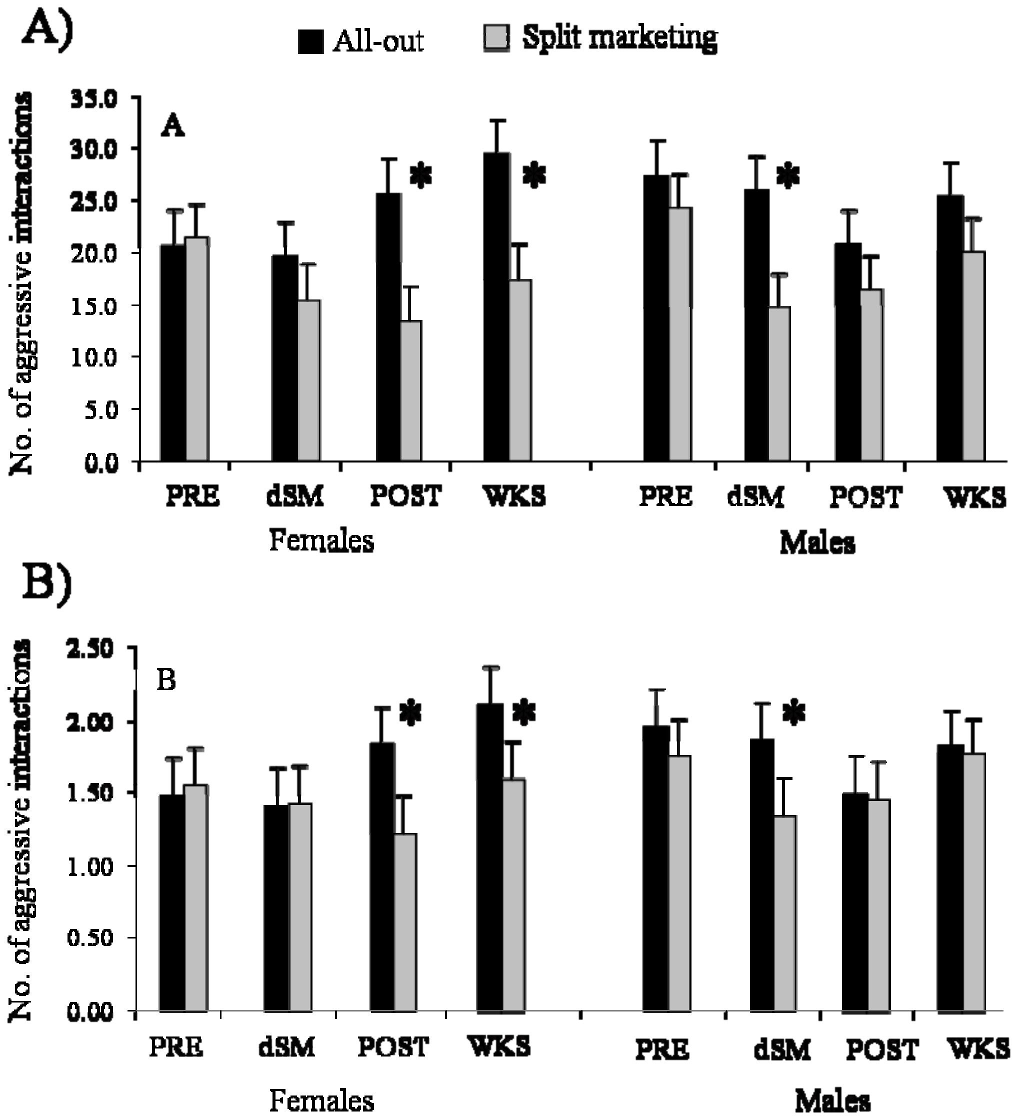

Figure 1. Number of aggressive interactions (means ± SED) during the morning and afternoon feeding events combined (6 min of observation) in All-Out and Split marketing (SM) groups for days before SM (PRE), the day of SM (dSM), days after SM (POST), and weeks after (WKS). Panel A: interactions within a pen. Panel B: interactions per pig. * = $P < 0.05$.

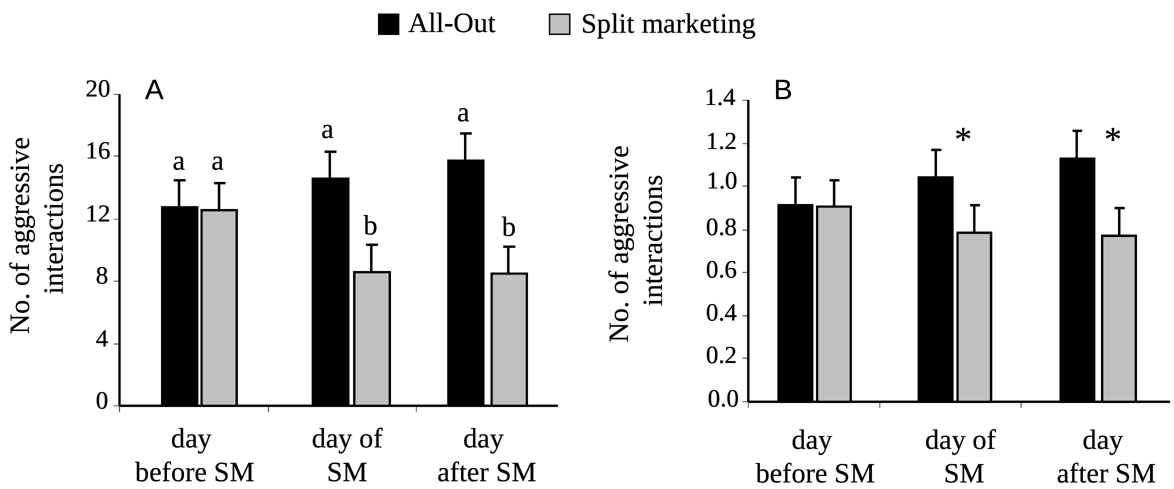

Figure 2. Number of aggressive interactions (means ± SED) during the night feeding event (3 min observation) in All-Out and Split marketing (SM) groups for the day before SM, the day of SM and the day after SM. Panel A: interactions within a pen; means without a common superscript (a-b) differ ($P < 0.05$). Panel B: interactions per pig; * = $P < 0.05$.